

WORD SKIPPING IN READING ENGLISH AS A FOREIGN LANGUAGE: EVIDENCE FROM EYE TRACKING¹

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Abstract. During reading, readers never fixate on all words in the text; shorter words sometimes gain zero fixation and skipped by the reader. Relying on E-Z Reader Model, this research hypothesized that a similar skipping effect also exists for a second language. The current study examined word skipping rates in EFL (English as a Foreign Language) with 75 EFL learners by using eye tracking methodology. The results showed that word skipping was affected by EFL reading proficiency significantly and articles (a, an, the) were skipped more than content words. Furthermore, more skilled learners were observed to have less fixation count and skipped more words during reading while less skilled learners employed more fixations and skipped less words. Eye tracking as a novel method to observe learner development and progress in EFL reading was also discussed.

Keywords: *word skipping, EFL, reading, eye tracking, second language.*

Долгунсоз Емраг, Сарісобан Аріф. Ігнорування слів під час читання англійською мовою як іноземною: дані окулоmotorної активності.

Анотація. Під час читання читачі ніколи не фіксують погляд на всіх словах у тексті, а на коротких словах іноді взагалі не затримують погляду або ігнорують. Автори цієї статті, ґрунтуючись на моделі E-Z Reader, висунули гіпотезу про те, що подібний ефект існує також і під час процесу читання другою мовою. У статті представлено дослідження на основі методу окулографії – відстеження руху очей, в якому взяло участь 75 осіб, які вивчають англійську як іноземну. Метою експерименту було визначення кількості ігнорованих слів під час читання англійською. Результати дослідження показали, що на кількість проігнорованих слів під час читання суттєво впливає показник біжучості читання. Артикли (a, an, the) випадали з поля зору читачів частіше, ніж повнозначні слова. Крім того, встановлено, що більш досвідченим студентам в більшій мірі властиво менша кількість фіксування погляду на словах, частіші випадки їхнього цілковитого ігнорування. Натомість менш досвідчені студенти демонстрували вищу кількість фіксування погляду на словах, рідші випадки ігнорування слів у тексті. Метод реєстрації руху очей автори кваліфікують як новий спосіб оцінки успішності оволодіння чужоземною мовою та поступу в розвитку навичок читання цією мовою.

Ключові слова: *ігнорування слів, англійська мова як іноземна, відстеження руху очей, друга мова.*

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1. Introduction

In English as a Foreign Language (EFL) reading, articles (a, an, the) are one of the most frequent and shortest units that an EFL learner faces throughout the reading process. Indeed, their significance in building a meaningful textual structure cannot be denied. However, eye movement research in English language as L1 revealed that frequent and short words, especially articles are skipped by L1 readers most of the time (Rayner, 1998). The present study hypothesizes that same effect also exists for EFL learners and the rate of skipping is closely associated with EFL reading proficiency and parafoveal capacity.

Word Skipping and Eye Movements

Throughout the reading process, not all words are fixated by the readers. Frequency and length of a word and its predictability in the context determine how much it is fixated. More frequent, shorter and highly predictable words are fixated less most of the time (Inhoff & Rayner, 1986; Rayner, Sereno, & Raney, 1996; Schilling, Rayner, & Chumbley, 1998; Binder, Pollatsek, & Rayner, 1999; Rayner, & Well, 1996). And sometimes some words take “zero fixation” and they are skipped by the reader. Carpenter and Just (1983) point out that content words are fixated about 85 % of the time, whereas function words are fixated about 35 % of the time. According to Rayner (1998), about 30 % of the words in a text are skipped and gain zero fixation. This skipping rate is closely related with the length of the word; short words are skipped more. (Brysbaert & Vitu, 1998; Drieghe, Brysbaert, Desmet, & De Baecke, 2004). In addition to length, predictability also has an effect on word skipping. Words which can easily be predicted from the context tend to be skipped by the readers (Altaribba, Kroll, Sholl, & Rayner, 1996; Balota, et al., 1985; Drieghe et al., 2004; Rayner, Binder, Ashby, & Pollatsek, 2001). Additionally, high frequency words are skipped more than low frequency words (Henderson & Ferreira, 1993; Radach & Kempe, 1993; Rayner & Fischer, 1996). It is obvious that lexical, morphological and visual features of a word predict word skipping. However, skipping during reading does not refer “unawareness” of the related word due to the foveal effects. Human visual acuity is about 2 degrees (Rayner, 1998) which is called fovea. Readers, however, also make use of peripheral vision to a certain degree called parafovea which is beyond the fovea depending on their experience in reading and reading proficiency. Thus, readers actually pay covert attention to the skipped words but do not execute overt attention as a result of parafoveal capacity.

E-Z Reader Model

Eye tracking technique is the online monitoring of eye movements via infrared illumination. With the help of an eye tracking software, infrared reflected onto the cornea tracks eye movements on a screen. The online monitoring of eye movements enables objective and robust data to examine the relationship between cognitive mechanisms and reading processes relying on the “Eye-Mind Hypothesis” (Just & Carpenter, 1980) which assumes that eye movements and cognitive processes are closely associated.

Having been inspired by Morrison’s Oculomotor Theory (1984), the E-Z Reader model (Reichle, Pollatsek, Fisher, & Rayner, 1998; Pollatsek, Reichle, & Rayner, 2003; Rayner, Reichle, & Pollatsek, 2005) is a quantitative model of skilled reading which

helps to explain the relationship between cognitive processes and eye movement control during reading. According to this model, recognition of a word begins with the attention on that word. This recognition process is completed in 2 phases: early and late stages. In the first stage, orthographic form of the word is processed in which the familiarity of the word is checked. Once this process is efficiently done, next saccade is planned. This stage is the very initial phase of lexical access. The second stage of word recognition involves the identification of a word's morphological and semantic forms. In this stage, lexical access may occur or not. In terms of word skipping, E-Z Reader model explains that a word is skipped because it is recognized in parafoveal vision with covert attention. When the eyes fixate $WORD_N$, and accomplish the second phase of word recognition, attention is moved to the following word; $WORD_{N+1}$. However, if the $WORD_{N+1}$ is short, frequent and predictable enough along with higher reading proficiency, it is likely to be recognized during parafoveal processing, albeit not fixated but still recognized. In other words, this serial processing model explains that apart from the overt attention during a fixation, covert attention is also paid to the upcoming word. When the following word with skipping features is processed enough during covert attention, it is skipped.

Eye Tracking in Second Language Research

The examination of cognition during reading process in second or foreign language by using eye tracking is fairly new when compared to L1 eye movement research. In L2, main topics examined were noticing hypothesis and incidental vocabulary acquisition during reading (Smith, 2012; Godfroid et al., 2013; Dolgunsöz, 2015), idiom processing in a second language (Siyanova et al., 2011), caption reading behavior, (Winke et al., 2013b), the effect of morphological instruction on eye movements (Liu, 2014), binding theory and extragrammatical information processing (Kim et al., 2015), grammatical judgement and scanpath analysis (Godfroid et al., 2015). In general, main issues scrutinized through eye tracking in L2 research were incidental vocabulary acquisition, idioms and caption reading, crosslinguistic differences, behavior. Word skipping and reading proficiency effects in L2 reading have not yet been examined.

Current Research

Depending on the E-Z Reader Model and L1 reading research, it is hypothesized that similar word skipping effects can also be found in EFL reading. In other words, articles as short, predictable and frequent words may tend to be skipped more than longer content vocabulary by EFL learners during EFL reading. Indeed this skipping rate is also hypothesized to be associated with EFL reading proficiency; better learners with better syntactic skills have faster automatization in sentence processing which may then lead them to skip articles more. The present study is significant as word skipping issues in EFL reading is scrutinized for the first time. The following research questions are addressed:

1. What is the rate of article skipping among learners of ELF during reading?
2. Is there a significant effect of EFL reading proficiency on skipping articles?
3. What is the relationship between characters read per saccade (CRS) and article skipping?

4. Is there a statistical difference between articles and content words regarding word skipping?

2. Methods

Participants. 75 EFL learners (15 males, 60 females) participated in the research. The participants were freshman and sophomore students in an ELT department in a state university. The age range of the participants was from 18 to 22. All learners started learning English as a foreign language in Turkey at a late age about 14 (national secondary education age) with the same L1 background. Participants' level of proficiency in English was at least B1 (27 B1 level, 38 B2 level and 10 C1 level learners). All participants had either normal or corrected-to-normal eyesight.

Materials. The stimulus was a natural L2 reading text without any manipulation of linguistic features. To foster validity and reliability, a standard IELTS (International English Language Testing System) General Reading passage was retrieved from the internet (www.ieltsexam.net/docs/reading/IELTS_Reading_General_13_Passage_1.htm). The reading passage was composed of 203 words, 1297 characters and 11 sentences. To promote natural reading, the passage was presented as a whole rather than in sentence by sentence fashion. To avoid any bias and to check whether participants really read the text for comprehension purposes in parallel with the purpose of the experiment, a multiple choice comprehension test with 3 items was prepared by the researcher. First question assessed the main topic of the paragraph and last 2 questions tested some details such as numbers and places mentioned in the text. This test was given to the participants right after the eye tracking session. All participants were observed to have responded correctly for all 3 questions.

AOIs for Content words and Articles

To assess article skipping rates, 10 articles (a, an, the) in the text were selected. To analyze word skipping rates on content words, 10 content words were selected in various frequency and length. The frequency of words was defined by COCA (Corpus of Contemporary American English). Detailed information is given below:

<i>AOI</i>	<i>LENGTH (characters)</i>	<i>FREQUENCY</i>
<i>To travel</i>	6	36197
<i>Survey</i>	6	32827
<i>Billion</i>	7	66979
<i>Domestic</i>	8	27446
<i>To combine</i>	7	12277
<i>Agriculture</i>	11	11750
<i>Souvenirs</i>	9	1033
<i>Accommodation</i>	13	2133
<i>To pour into</i>	9	874
<i>Manufacturing</i>	13	12034
<i>MEAN</i>	8,9	20355

Defining Vocabulary scores for content words

To assess participant word familiarity on 15 AOIs, a vocabulary knowledge scale as both unannounced pre-test and immediate post-test was designed (see Joe, 1995; McNeill, 1996; Scarcella and Zimmerman, 1998; Wesche and Paribakht, 1996). In this scale learners were required to choose the best of 3 options: “I know the word”; “I am familiar but not sure”; and “I have no idea”. If one of the first 2 options were chosen, participants should write the Turkish meaning(s) or their predictions about the word. This scale is used in unannounced vocabulary test. Participants successfully recognized about 70 % of the words. To scrutinize article skipping, 10 articles, namely “a, an, the” were defined as areas of interest (see Appendix 1).

Apparatus

Eye movements were recorded with the Tobii TX300 with a sampling rate of 300Hz, equivalent to a temporal resolution of 3.3ms. For eye movement data acquisition, visualization and analysis, Tobii Studio Enterprise Software 3.2.3 was used.

Calculating Fixation Count

Fixation count refers to the number of times a participant had a fixation on the screen (Djamasbi et al., 2011). Depending on E-Z Reader Model, it is assumed that less fixation count refers to longer saccade span.

Procedure

All participants were volunteers, naïve to the research questions and tested individually. To assess learners’ EFL reading proficiency, a sample IELTS General Reading test was conducted. Before the experiments, learners sat for the unannounced vocabulary test. Then, each participant sat for the eye tracking session one by one within the control of the researcher. They were instructed to read the passage silently for comprehension purposes. To avoid anxiety and emotional arousal which might cause cognitive reactivity, no time limit was given; participants were asked to read freely and naturally to understand the text. Calibration was done with a 9 point grid calibration setting. The texts were presented in Times New Roman, 18-pt font, on a 23” monitor with 1920x1080 screen resolution set up at 67 cm from the participants’ eyes. Right after the experiment, each participant took the brief comprehension check test.

3. Results

All variables in the data set were observed to have distributed normally. For statistical tests, all assumptions were met including homogeneity of variances, linearity, additivity and sample size.

The rate of skipping articles in EFL reading

To calculate the skipping rate of articles, zero fixations on 10 occasions of interest were counted for each participant with the eye tracking software. In general, EFL learners were observed to have skipped nearly half of the articles ($M=4.26$, $SD=1.54$, $N=75$). This mean value equals to a skipping rate of 43%. A detailed table

is given below:

Table 1

Article skipping rate during EFL Reading

	N	Min	Max	Mean	SD	%
Article skipping	75	,00	8,00	4,2667	1,54512	43%

The relationship between EFL Reading Proficiency and Skipping Articles

Linear regression with proficiency scores as the predictor and article skipping count as the dependent variable revealed a significant effect of EFL reading proficiency on article skipping; $\beta = .097$, $t(74) = 2.811$, $p = .006$. Reading proficiency also explained a significant proportion of variance in article skipping: $R^2 = .098$, $F(1,73) = 7.904$, $p = .006$.

B1 learners skipped articles with a rate of 38 % (N=27) and B2 learners by 44 % (N=38). C1 learners skipped more than half of the articles (52 %, N=10). A significant effect of reading proficiency was observed on article skipping at the $p < .05$ level; [$F(2,72) = 3.304$, $p = .046$]. A detailed table is given below.

Table 2

Article skipping rates for 3 proficiency groups

		<i>N</i>	<i>Mean</i>	<i>%</i>	<i>SD</i>	<i>SE</i>	<i>95% CI for Mean</i>		<i>Min</i>	<i>Max</i>
							<i>LB</i>	<i>UP</i>		
<i>Article skipping</i>	<i>B1</i>	27	3.8148	38%	1.210	.232	3.33	4.29	1.00	6.00
	<i>B2</i>	38	4.3421	44%	1.712	.277	3.77	4.90	.00	7.00
	<i>C1</i>	10	5.2000	52%	1.316	.416	4.25	6.14	3.00	8.00
	<i>Total</i>	75	4.2667	43%	1.545	.178	3.91	4.62	.00	8.00

indicated a significant difference between article skipping ($M=4.26$, $SD=1.54$) and content word skipping ($M=0.12$, $SD=0.32$); $t(74)=22.812$, $p = .000$.

4. Discussion

The aim of the present research was to use eye tracking technique to investigate word skipping rates regarding articles and content words in EFL reading and its relationship with proficiency and characters read per saccade. The results showed that EFL learners did tend to skip nearly half of the articles during natural EFL reading process and this skipping rate was significantly affected by EFL reading proficiency and fixation count. On the contrary, content words were skipped only less than 5 % and did not show any correlation with fixation count. Firstly, articles as short and one of the most frequent units of English language, are mastered at early stages of EFL reading proficiency as B1 learners nearly skipped 40 % of them during reading. Secondly, better learners read more characters per saccade and have a longer saccadic span due to their syntactic and lexical superiority. Excluding cases of cognitive deficits or visual impairment, developmental eye movement research explained that eye movements do not differ in terms of oculomotor control but that fair amount of changes in eye movements are linguistic dependent (Schröder et al. 2005). This study confirmed that less skilled readers in EFL pay more attentional resources to the words and structures during reading and, as a result make more fixations and benefit less from extrafoveal information when compared to more skilled readers. Relying on E-Z Reader Model primarily proposing that a word is mainly skipped because it is recognized in parafoveal vision and recognized in extrafoveal processes, it can be assumed that skilled EFL learners make better use of parafoveal processing and skip short and frequent words more than less-skilled readers. This ability leads these learners to make less fixation count and increase reading efficiency. On the other hand, less skilled learners have a narrower parafoveal range and make less use of covert attention which cause them to pay more overt attention to the articles. Naturally, this inflates their fixation count and relatively decreases reading efficiency. Finally, this results of this research showed that word skipping also exists for EFL and E-Z Reader Model can help examine and interpret EFL reading processes in a different perspective.

5. Conclusions

The results of the currents research revealed that similar skipping effects observed in L1 reading in previous eye movement research also exist for EFL reading. Better learners read faster and employ less fixation count which enable them to recognize words in parafoveal process. Thus, skipping rates change depending on EFL reading proficiency. Furthermore, length has a significant effect on word skipping as content words are skipped less when compared to articles. Primarily, this research emphasized that eye movements during EFL reading are proficiency dependent and vary depending on reading proficiency. In this respect, eye tracking can enable the online and robust observation of learner progress

providing invaluable insights to any EFL reading problems that learners met. Thus, not more than a decade, eye tracking as a tool for EFL classrooms in which learner progress is observed objectively can be used for pedagogical purposes.

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APPENDICES

Appendix 1: Text Stimulus

AUSTRALIA

Have you ever travelled to another part of your country and stayed for a few days? Travel within one's own country is popular throughout the world. And, according to a survey carried out in Australia in 2002, travellers are spending more and more money on their holidays.

The Domestic Tourism Expenditure Survey showed that domestic travellers – those travelling within the country – injected \$23 billion into the Australian economy in 2002. As a result, domestic tourism became the mainstay of the industry, accounting for 75 % of total tourism expenditure in Australia. International tourism, on the other hand, added \$7 billion to the economy.

So, tourism has become one of Australia's largest industries. The combined tourist industry now accounts for about 5 % of the Australian economy, compared with agriculture at 4.3 % and manufacturing at 8 %. Tourism is therefore an important earner for both companies and individuals in a wide range of industries.

For example, the transport industry benefits from the extra money poured into it. Hotels spring up in resort areas to provide accommodation, and the catering industry gains as tourists spend money in restaurants. The retail sector benefits as well, as many tourists use their holidays to shop for clothes, accessories and souvenirs.

Appendix 2: Vocabulary Knowledge Scale

WORD	OPTIONS	TURKISH MEANING(S)
AGRICULTURE	<input type="checkbox"/> I KNOW THIS WORD!	
	<input type="checkbox"/> I AM FAMILIAR BUT NOT SURE.	
	<input type="checkbox"/> I HAVE NO IDEA!	